UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

December 20, 2023

Mr. Daniel H. Dorman
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REVIEW OF ADVANCED REACTOR CONTENT OF APPLICATION PROJECT/TECHNOLOGY-INCLUSIVE CONTENT OF APPLICATION PROJECT GUIDANCE

Dear Mr. Dorman:

During the 711th meeting of the Advisory Committee on Reactor Safeguards (ACRS), December 6-7, 2023, we completed our review of guidance documents related to the Advanced Reactor Content of Application Project (ARCAP), which encompasses the Technology-Inclusive Content of Application Project (TICAP). We previously discussed this topic in our subcommittee meetings held on March 17, 2021, July 21, 2021, December 17, 2021, and November 13, 2023. During these meetings, we had the benefit of discussions with representatives of the NRC staff and other stakeholders. We also benefited from the referenced documents.

Conclusions and Recommendations

1. The ARCAP/TICAP documents represent a significant effort by staff and industry to develop guidance for risk-informed technology-inclusive non-light water reactor (non-LWR) applications, including the use of the Licensing Modernization Project (LMP) methodology.

2. The 12-chapter structure in an ARCAP/TICAP Safety Analysis Report (SAR) is a logical ordering of the information. This structure enhances the focus on the important safety-relevant features in the design and should provide for efficient reviews of LMP-based applications.

3. The pre-application engagement guidance found in Appendix A of the ARCAP roadmap is excellent and supports our past recommendations on this topic. It should serve design developers and the staff as a useful starting point to align expectations for the application process and promote high quality submissions.

4. Further comments on specific guidance documents are found in the body of the letter.

Background

There is a need to develop a flexible regulatory framework in anticipation of a range of non-LWR licensing applications for construction permits (CPs), operating licenses (OLs), manufacturing

licenses (MLs), standard design approvals (SDAs), design certifications (DCs), and combined licenses (COLs). A key element of this new and flexible regulatory framework is the need to standardize the development of content for each class of non-LWR licensing applications, to support staff review consistency and predictability, and to provide a well-defined basis for evaluating proposed changes in review scope and requirements. The safety analysis in the application must be high quality and sufficiently detailed to enable the staff to determine whether the application satisfies the regulations for issuing the requested license, certification, or approval.

The purpose of ARCAP/TICAP is to provide technology-inclusive, risk-informed, and performance-based guidance to support near-term non-LWR applications under Title 10 of the *Code of Federal Regulations* (10 CFR) Parts 50 and 52. It is anticipated to be updated as the 10 CFR Part 53 regulations evolve. The ARCAP was developed to encompass all topics needed for a license application. Instead of the traditional 19-chapter SAR, a 12-chapter structure evolved from discussions with industry about LMP implementation. SAR chapters 1 through 8 largely focus on describing the fundamental safety functions, the principal design criteria, and the corresponding safety analysis.

The industry-led TICAP effort resulted in NEI 21-07, which provides guidance on the scope and level of detail in specific portions of the first eight chapters of the SAR associated with the LMP-based safety analysis:

- Chapter 1: General plant and site description and overview of the safety analysis
- Chapter 2: Methodologies and analyses
- Chapter 3: Licensing basis events
- Chapter 4: Integrated evaluations
- Chapter 5: Safety functions, design criteria and structures, systems, and components (SSC) classification
- Chapter 6: Safety-related with special treatment SSC criteria and capabilities
- Chapter 7: Non-safety-related with special treatment SSC criteria and capabilities
- Chapter 8: Plant programs

NEI-21-07 is endorsed by the staff with clarifications in draft Regulatory Guide 1.253[1]. Appendix A of this regulatory guide documents expectations for a probabilistic risk assessment (PRA) at the construction permit stage.

ARCAP guidance provides an overall roadmap for review of risk-informed technology-inclusive advanced reactor applications and outlines additional content that should be captured in the SAR. Interim staff guidance documents (ISGs) have been developed covering the following areas:

- Site information (Chapter 2)[2]
- Control of effluents, plant contamination and solid waste (Chapter 9)
- Control of occupational doses (Chapter 10)
- Organization and human-system consideration (Chapter 11)
- Post-construction inspection, testing and analysis program (Chapter 12)

[1] Draft Regulatory Guide 1.253 does not currently address MLs and SDAs. It encourages ML and SDA applicants to discuss their plans to use the regulatory guide with the NRC staff during the preapplication phase.

[2] Staff added scope related to site evaluations to TICAP Chapter 2.

Additional information needed for the application is described in ISGs on the following topics:

- Risk-informed Inservice Inspection (ISI)/Inservice Testing (IST) programs
- LMP-based approach to developing technical specifications, and
- Risk-informed and performance-based fire protection program.

Discussion

These documents represent a significant effort by industry and staff to develop guidance for risk-informed technology-inclusive non-LWR applications using the LMP methodology. The 12-chapter structure in ARCAP/TICAP is a logical ordering of the information. This structure enhances the focus on the important safety-relevant features in the design and should provide for efficient reviews of LMP-based applications. In the sections below we provide our comments on the draft Regulatory Guide 1.253 and several of the ISGs.

Roadmap for review of risk-informed technology-inclusive advanced reactor applications. The document provides a good roadmap to all the relevant guidance on each of the topic areas covered in the individual ISGs. The pre-application engagement guidance found in Appendix A is especially important because many of the ISGs and guidance documents rely heavily on pre-application engagement by design developers. It is excellent and supports our past recommendations on this topic. The list of example topical reports covers important technical issues on:

- the specific advanced reactor technology (e.g., fuel qualification, materials qualification and relevant codes and standards, mechanistic source term),
- design and safety aspects (e.g., fundamental safety functions, principal design criteria, selection of licensing basis events, classification of SSCs, and safety analysis methods and validation), and
- policy issues (e.g., emergency planning, functional containment implementation) that may need to be resolved.

The document also discusses the value of preapplication white papers for presenting novel methodologies and issues. This appendix should serve design developers and the staff as a useful starting point to align expectations.

Draft Regulatory Guide 1.253. As noted above, this document endorses, with clarifications, NEI 21-07. We reiterate the importance of a comprehensive hazard analysis and a thorough accident identification process for producing a good application. In this context, we urge the staff to expedite conversion of draft Regulatory Guide 1.254, “Technology-inclusive Identification of Licensing Events in Commercial Nuclear Power Plants,” into an approved regulatory guide so that near-term non-LWR applicants can use this guidance in their 10 CFR Parts 50 and 52 applications rather than waiting until 10 CFR Part 53 is finalized.

Staff guidance does not clarify the relationship among the terms ‘fundamental safety functions,’ ‘required safety functions,’ and ‘necessary safety functions.’ NEI 21-07 identifies the terms ‘fundamental safety functions,’ ‘PRA safety functions,’ and ‘required safety functions.’ Staff should define the terms used in their guidance and discuss the need for documentation of the rationale used to identify these functions.

The acceptability of the PRA is based on an evaluation of: its scope; level of detail; elements (technical analyses, characteristics and attributes); adequacy of plant representation; and PRA configuration control. The appendix to draft Regulatory Guide 1.253 evaluates the technical requirements from the non-LWR PRA standard and establishes those required at the CP stage for a minimally acceptable PRA. Because final design information may not be developed at the CP application stage, especially for a first-of-a-kind unit, the associated PRA would be considered preliminary, less mature and of smaller scope than it will be at the OL stage. Nevertheless, assurance should be provided that the PRA results are reasonable (given the level of maturity of the design) and that the SAR provides sufficient information to support the CP findings. The application should also include commitments to upgrade and maintain the PRA so that its maturity at the OL stage is consistent with its intended uses.

There is insufficient guidance in this regulatory guide or NEI 21-07 on how the evaluation of cliff edge effects is to be documented in the SAR. The LMP methodology requires determining whether cliff edge effects are present, and other documents (such as Regulatory Guide 1.242) require addressing cliff edge effects as part of the overall plant design. However, as discussed in INL/EXT-20-60392, the LMP does not specifically identify a methodology to determine whether a specific non-LWR design exhibits cliff edge effects. INL/EXT-20-60392 notes that the method recommended by the International Atomic Energy Agency (IAEA) in Specific Safety Guide (SSG)-2 for identifying cliff edge effects is “the performance of sensitivity studies using the deterministic models for evaluating the plant response to events.” The staff should consider this IAEA guidance or comparable guidance. Furthermore, a subsection of the appropriate SAR chapter should be identified for discussion of both the process and the results for cliff edge determination.

Organization and human-system consideration. This guidance discusses the need for a description of the organizational structure and key management positions in the design, construction, and operating organizations that are responsible for facility design, design review, design approval, construction management, testing, and plant operation. The ISG also addresses the topics of human factors engineering, operating training and licensing, and use of simulators.

Rather than relying heavily on NuScale as a precedent, guidance should emphasize the factors noted in our May 21, 2021, letter on control room staffing. These include relevant design details, passive or inherent safety features, accident progression timing, safety margins, the reliance on operator intervention, a thorough safety test program, and a robust operator training and simulator validation program.

Post-construction inspection, testing and analysis program. In general, this ISG will provide the NRC reviewer with adequate guidance to assess the Post-construction Inspection, Testing, and Analysis Program (PITAP). To make this guidance more complete, consider the following:

1. The lack of any guidance on building environmental conditions (heating, cooling, ventilation, lighting, etc.) is notable considering that new reactors may be sited in harsh and remote environments. Building environmental conditions should be explicitly noted to remind the reviewer to assess unusual environmental conditions that may impact SSCs for a given reactor design.

2. The retention and organization of records are vital for efficient and effective NRC audits and inspections prior to final issuance of an OL, ML, or COL. The ISG mentions test

reports and the need for NRC inspections; however, the need to keep all records organized and complete should be emphasized.

3. Acronyms should be defined.

Risk-informed ISI/IST programs. This ISG will provide the NRC reviewer with adequate guidance to assess the risk-informed ISI/IST programs for non-LWR license applications. The guidance can be made more complete by considering the following:

1. Much was learned about the behavior of materials used in LWRs, even after decades of operation. The guidance should retain an element of nimbleness to adapt to lessons learned and operating experience that will be gained as new non-LWRs develop their own unique operating experience.

2. Concepts that are new, such as “Components that Control Fluid without Mechanically Interacting with the Fluid,” should be a focus for industry interaction to ensure alignment on expectations for license applications.

3. Documents referenced in the body of the document, such as NEI 18-04, should be added to the reference section.

The document is very thorough and easy to understand. It augments the ISG developed for materials compatibility for advanced reactors (DANU-ISG-2022-01).

Risk-informed and performance-based fire protection program. In general, this ISG will provide the NRC reviewer with adequate guidance to assess the fire protection program. Because of the need to be technology inclusive, there is inexact language built into the guide that can cause regulatory uncertainty. The approach proposed in this ISG practically suggests that the “voluntary” pre-application process may be largely mandatory because several key assumptions (such as use of National Fire Protection Association codes not endorsed by the NRC) must be vetted through the NRC staff prior to expenditure of significant applicant/designer resources to design an acceptable program. Furthermore, the ISG assumes the advanced non-LWR site will have a fire brigade and is silent on any extension of qualifications, training, or agreements with offsite resources. Not all non-LWR plant organizations will have a fire brigade, essentially relying on offsite resources. The ISG is silent on guidance for the situations where the applicant opts for primary reliance on offsite fire response. Guidance should be developed (or existing guidance referenced) to ensure the emergency planning and offsite coordination is appropriate for an operational fire protection program.

Other Comments. ARCAP guidance and the suite of ISGs do not contain planning requirements for decommissioning. To establish adequate financial qualifications to construct and operate the facility, a high-level decommissioning strategy, at a minimum, should be described in the SAR.

Summary

The ARCAP/TICAP documents represent a significant effort by staff and industry to develop guidance for risk-informed technology-inclusive non-LWR applications, including the use of the LMP methodology. The 12-chapter structure in an ARCAP/TICAP SAR is a logical ordering of the information. This structure enhances the focus on the important safety-relevant features in the design and should provide for efficient reviews of LMP-based applications. The

pre-application engagement guidance found in Appendix A of the ARCAP roadmap is excellent and supports our past recommendations on this topic. It should serve design developers and the staff as a useful starting point to align expectations for the application process and promote high quality submissions. We look forward to interacting with the staff as they address the comments in this letter.

Sincerely,

Signed by Rempe, Joy on 12/20/23

Joy L. Rempe
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, Draft Advanced Reactor Content of Application Project (ARCAP) and Technology-Inclusive Content of Application (TICAP) Interim Staff Guidance Documents, DANU-ISG-2022-01 through DANU-ISG-2022-09, Predecisional Documents to Support ACRS Meeting, October 31, 2023. (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23283A092)

2. U.S. Nuclear Regulatory Commission, "Domestic Licensing of Production and Utilization Facilities," 10 CFR Part 50.

3. U.S. Nuclear Regulatory Commission, "Licenses, Certifications, and Approvals for Nuclear Power Plants," 10 CFR Part 52.

4. U.S. Nuclear Regulatory Commission, "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," 10 CFR Part 53, Draft Rule for Comment. (RIN 3150-AK31)

5. Nuclear Energy Institute, "Technology Inclusive Guidance for Non-Light Water Reactors: Safety Analysis Report Content for Applicants Utilizing NEI 18-04 Methodology," NEI 21-07, Revision 1, February 2022. (ML22060A190)

6. U.S. Nuclear Regulatory Commission, "Guidance for a Technology-Inclusive Content-of-Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," Post Comment Resolution Draft Regulatory Guide 1.253, Revision 0, Predecisional Document to Support ACRS Meeting, October 31, 2023. (ML23283A103).

7. U.S. Nuclear Regulatory Commission, "Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants," Draft Regulatory Guide DG-1413, *Proposed new Regulatory Guide 1.254*, Predecisional Document to Support ACRS Meeting, September 28, 2022. (ML22272A042)

8. U.S. Nuclear Regulatory Commission, "Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, And Non-Power Production or Utilization Facilities," Regulatory Guide 1.242, Revision 0, November 2023. (ML23226A036)

9. Moe, W. L., and A. Afzali, “Modernization of Technical Requirements for Licensing of Advanced Non-Light Water Reactors: LMP Lessons Learned, Best Practices, and Frequently Asked Questions,” INL/EXT-20- 60392, Revision 0, March 2020.

10. International Atomic Energy Agency, “Deterministic Safety Analysis for Nuclear Power Plants,” Specific Safety Guide (SSG)-2, Revision 1, 2019.

11. Advisory Committee on Reactor Safeguards, Letter to Executive Director of Operations Doane, U.S. Nuclear Regulatory Commission, “NuScale Topical Report – Control Room Staffing Plan,” May 21, 2021. (ML21139A226)

12. Nuclear Energy Institute, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development,” NEI 18-04, Revision 1, August 2019. (ML19241A472)

13. U.S. Nuclear Regulatory Commission, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications – Roadmap,” Draft Interim Staff Guidance, DANU-ISG-2022-01, October 2023. (ML23277A139)

December 20, 2023

SUBJECT: REVIEW OF ADVANCED REACTOR CONTENT OF APPLICATION PROJECT/TECHNOLOGY-INCLUSIVE CONTENT OF APPLICATION PROJECT GUIDANCE

Accession No: ML23348A182 **Publicly Available (Y/N):** Y **Sensitive (Y/N):** N
If Sensitive, which category?
Viewing Rights: ☒ NRC Users or ☐ ACRS only or ☐ See restricted distribution

OFFICE	ACRS	SUNSI Review	ACRS	ACRS	ACRS	ACRS
NAME	DWidmayer	DWidmayer	LBurkhart	RKrsek	SMoore	JRempe
DATE	12/14/23	12/14/23	12/14/23	12/18/23	12/18/23	12/20/23

OFFICIAL RECORD COPY